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Lower Passaic River, Newark Bay and NY/NJ Harbor: Dredged Material Management (DMM)

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Technical Assistance: *In 2004 the Passaic River Coalition was provided with a Technical Assistance Grant (TAG) by the U.S. Environmental Protection Agency (EPA) to help communities near the Diamond Alkali Superfund Site be informed and participate in decision making about cleaning up this site. Anne L. Kruger, Ph.D., was chosen as Technical Advisor because she has the scientific expertise that is required to understand and evaluate the interconnectedness of the many factors that impact the ecologic health and vitality of the Lower Passaic River Basin and New York Harbor estuary. For about half a century she has been involved in various ways in trying to clean up the environment of the New Jersey/New York area, with an emphasis on the reduction of pollution from hazardous wastes. Her doctoral dissertation was about a study of industrial waste generation and disposition in New Jersey.[1] Of all the sites in New Jersey and New York polluted by industrial wastes which she has studied, she finds that development of cleanup plans for the Diamond Alkali Superfund Site to be most challenging.*

Critical Need to Dredge

The Lower Passaic River and Newark Bay are critical parts of the New York and New Jersey Harbor, a hub of economic activity since the start of the Industrial Revolution over two centuries ago, because these waters provide shipping access to the world. (See Figure 1.[2]) Many of the industries which developed alongside the Passaic River and throughout the NY/NJ Harbor wanted easy access to shipping, but shipping sometimes requires that the navigation channels be dredged. Some of these industries left a legacy of contaminants in the sediments of these waters which persist today. Because of this pollution most of the Lower Passaic River has not been dredged since the 1940s. The navigation channels in the Lower Passaic River and Newark Bay that should be dredged are shown in Figure 2.[3]

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1 Kruger, A. L. 1982. Industrial Wastes: Generation and Disposition in New Jersey. PU/CEES Working Paper No. 55. Hazardous Waste Research Program, Center for Energy and Environmental Studies, School of Engineering/Applied Science, Princeton University, Princeton, NJ.

2 Tierra Solutions, Inc. 2008. Phase I and Phase II Field and Data Report, Newark Bay Study Area Remedial Investigation. Phase I and Phase II Sediment Investigation Field and Data Report, Figure 1-1.

3 Tierra Solutions, Inc. 2008. Phase I and Phase II Field and Data Report, Newark Bay Study Area Remedial Investigation. Phase I and Phase II Sediment Investigation Field and Data Report, Figure 4-13.

Figure 1 – NY/NJ Harbor Region

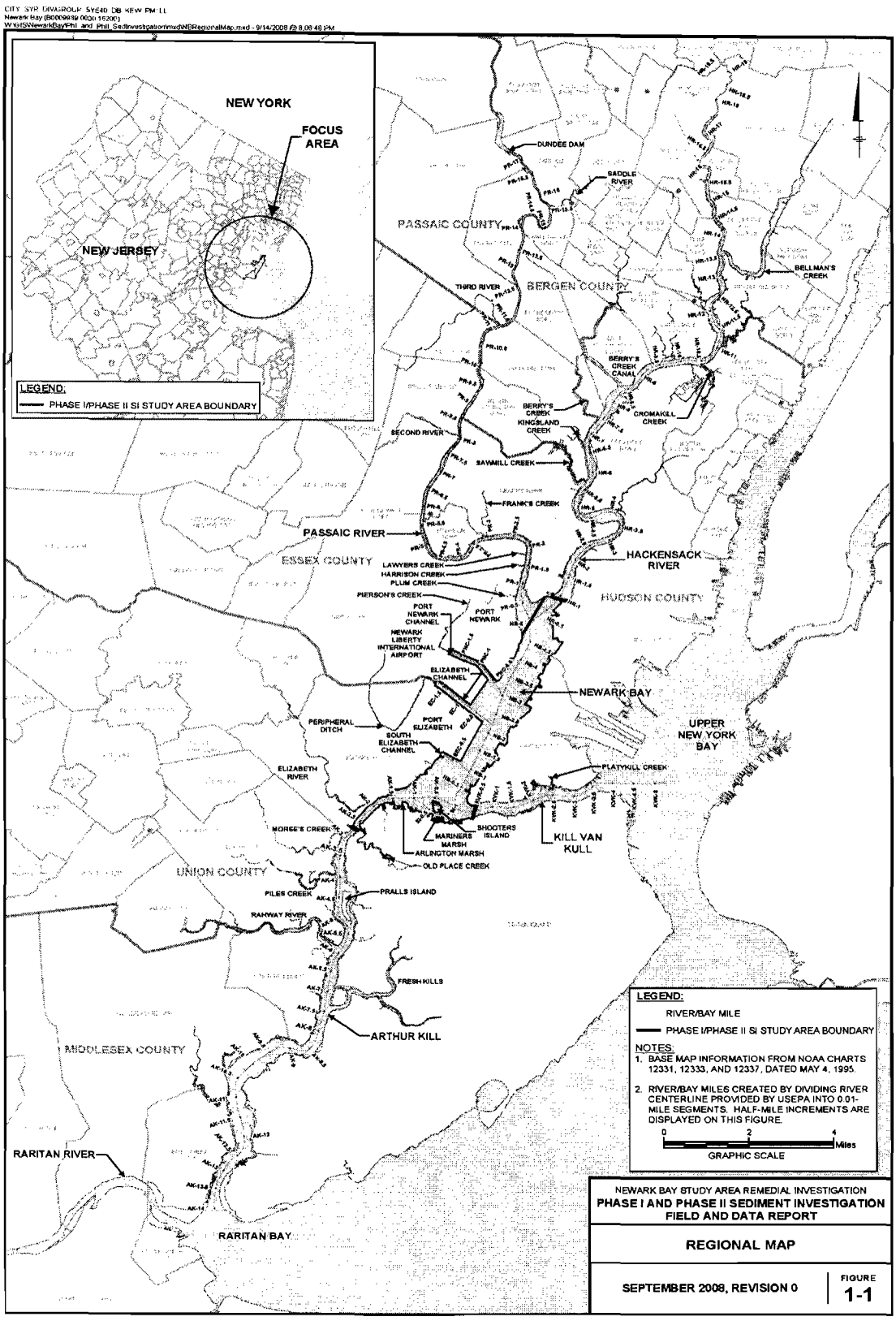
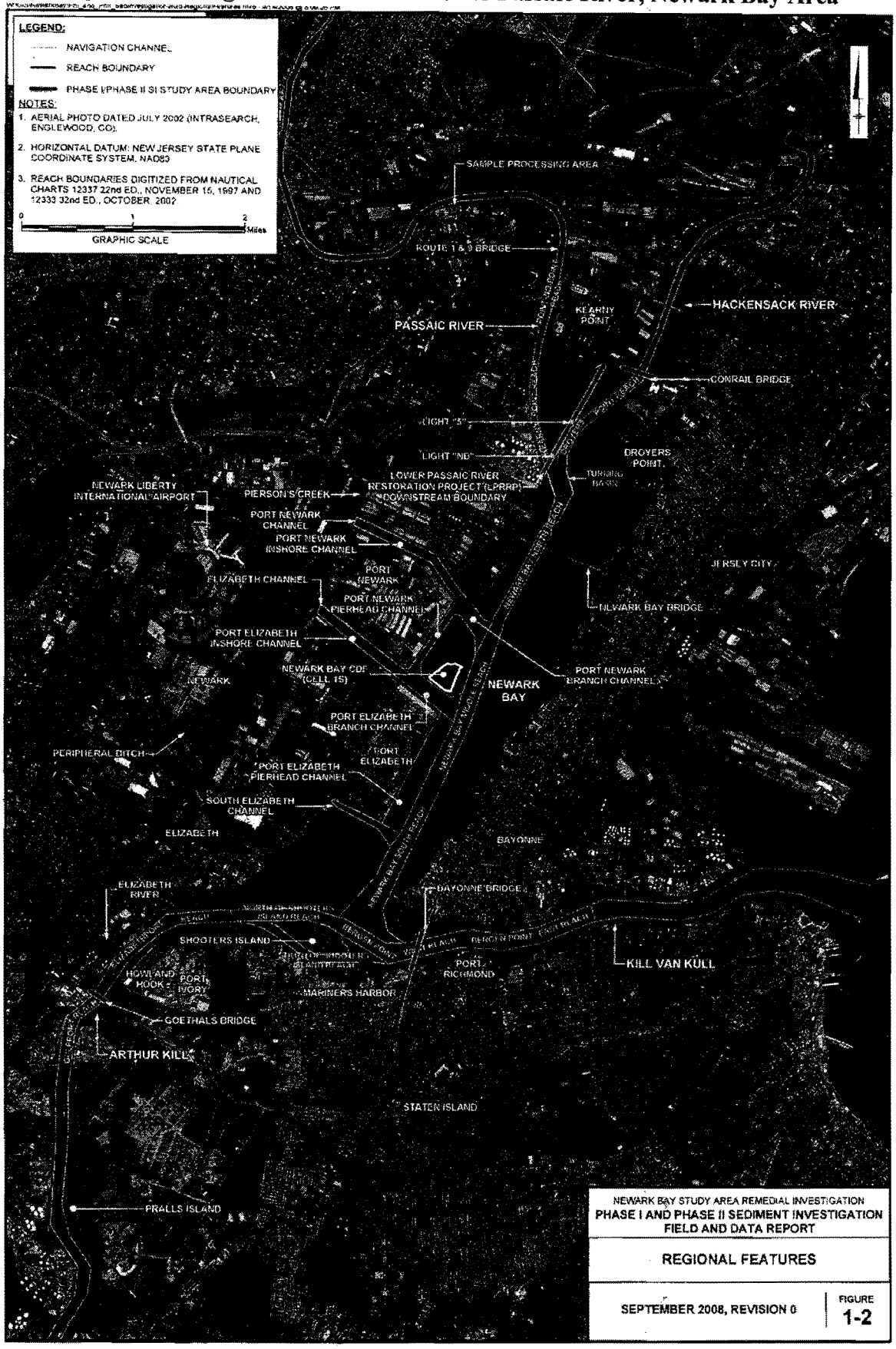


Figure 2 – Navigation Channels in Lower Passaic River, Newark Bay Area



The dumping of contaminated dredged materials from the harbor into the ocean at the "Mud Dump Site", which became the Historic Area Remediation Site (HARS), was stopped in 1997. (See Figure 3.) In 2000 the U.S. Army Corps of Engineers (Corps) recognized the need to develop plans for deepening the navigation channels throughout the NY/NJ Harbor.[4] The channels range in depths from 30 to 45 feet which are inadequate to provide access to large ships which have drafts of 48 feet or more. The navigation channels that should be deepened in this project are shown in Figure 4.[5] Dredging contracts have been completed for the hatched areas shown in Figure 4. However, since 2008 there has been no Dredged Material Management (DMM) Plan for the contaminated sediments that need to be dredged in Newark Bay and elsewhere in the harbor.[6] The "Non-HARS Suitable Holocene Sediments", which need to be dredged from the Arthur Kill between Elizabeth, NJ and Staten Island, NY (Area S-AK-2 in Figure 4) and which are contaminated, are supposed "to be processed into amended dredged material and used beneficially in the ongoing remediation of suitable state approved upland remediation or construction location(s)".[7] This requirement cannot be met at this time.

The Port Authority of New York & New Jersey proposes wharf reconstruction, maintenance dredging, and berth deepening at berths 4, 6 and 8 at the Port Newark Marine Terminal in Newark Bay.[8] About 55% of the material that needs to be dredged from the Terminal is too contaminated and not suitable for placement at the HARS in the ocean, which is shown in Figure 3.[9] This dredged material might be "disposed of but not processed, due to the nature of the material, at a state-approved facility."[10] However, there is no such facility in New Jersey or New York for such dredged materials.

The Corps notes that "the Port of New York and New Jersey must be dredged to maintain navigation and commerce estimated to generate about $20 billion annually in direct and indirect benefits. Due to past and present pollution, managing dredged material from many areas of the Port has posed both challenges and opportunities."[11] Now, in a time of economic hardship, it is critical that the NY/NJ Harbor's navigation channels be deepened, and water transportation infrastructure be repaired so that the shipping industry can continue its many benefits for the region, the entire country, and especially for the many residents and workers in the densely populated urban areas surrounding the Lower Passaic River and Newark Bay. Now is the time to meet this challenge to develop a Dredged Material Management (DMM) Plan that gives "special emphasis to beneficial uses of the material needing to be dredged to maintain efficient waterborne transportation into and out of the Port."[12]

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[4] U.S. Army Corps of Engineers, New York District. 2011. New York & New Jersey Harbor (50 ft Deepening) Navigation Project. Bryce Wisemiller, Project Manager. Web-site: www.nan.usace.army.mil.

[5] U.S. Army Corps of Engineers, New York District. Public Notice Number: FP65-S-AM-3B-2011. Issue Date: 21 June 2011.

[6] U.S. Army Corps of Engineers, New York District. 2011. Dredged Material Management Plan for the Port of New York and New Jersey. Michael Millard, Project Manager. Web-site: www.nan.usace.army.mil.

[7] U.S. Army Corps of Engineers, New York District. Public Notice Number: FP63-SAK2-2011. Issue Date: 26 May 2011. Page 4.

[8] Application by Port Authority of New York & New Jersey to US Army Corps of Engineers, New York District, Public Notice Number: NAN-2010-00914-WSC. Issue Date: April 12, 2011.

[9] Figure 1: U.S. Army Corps of Engineers, New York District. Public Notice Number: FP63-SAK2-2011. Issue Date: 26 May 2011. Figure 4.

[10] *Op. Cit. #8.* Page 4.

[11] U.S. Army Corps of Engineers, New York District. 2011. Dredged Material Management Plan for the Port of New York and New Jersey. Michael Millard, Project Manager. Web-site: www.nan.usace.army.mil.

[12] *Ibid.*

Figure 3 -- Historic Area Remediation Site (HARS)[13]

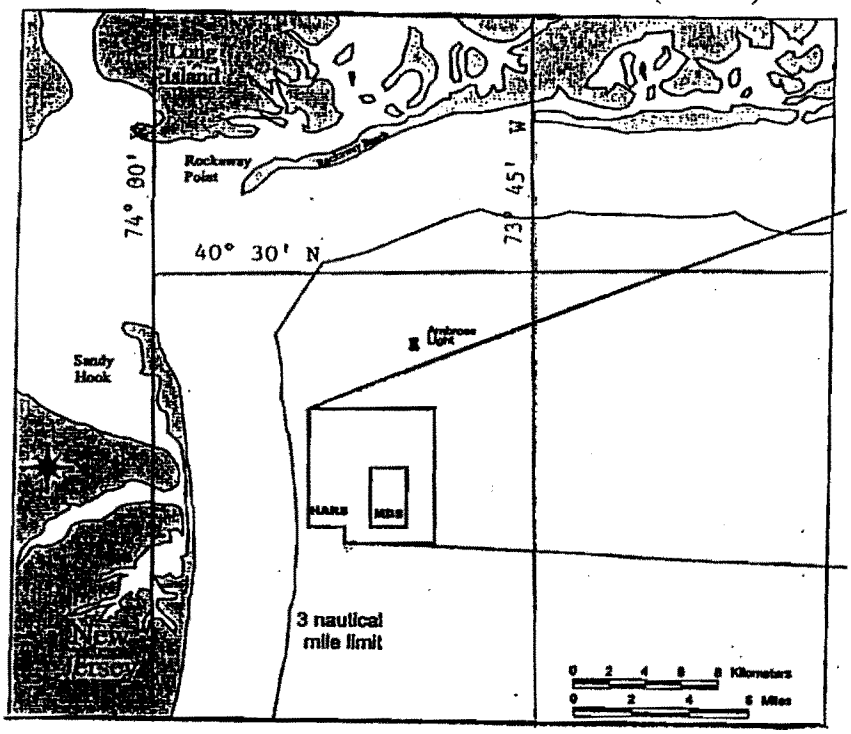
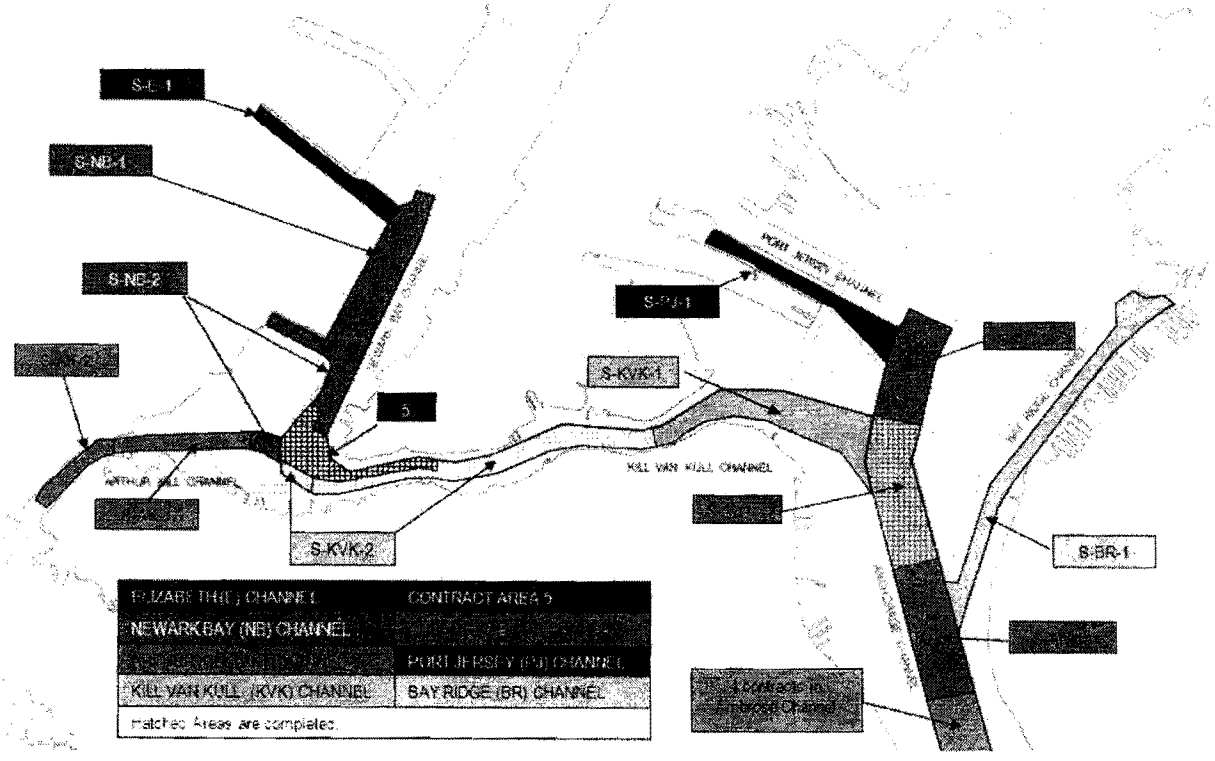


Figure 4 – NY/NJ Harbor Deepening Navigation Project[14]



[13] U.S. Army Corps of Engineers, New York District. Public Notice Number: FP63-SAK2-2011. Issue Date: 26 May 2011. Figure 4.

[14] U.S. Army Corps of Engineers, New York District. Public Notice Number: FP65-S-AM-3B-2011. Issue Date: 21 June 2011.

Legacy Sediment Contaminants: PCBs and Dioxin

To repair this vital infrastructure for the Port of New York and New Jersey, sediments that contain many contaminants will have to be dredged. In order to plan for the Dredged Material Management (DMM) of sediments to be dredged from the NY/NJ Harbor it is useful to know something about the history and chemistry of the sediment contaminants of greatest concern, PCBs and dioxin.

In 1998 the New York Academy of Sciences Harbor Consortium began studying five contaminants (mercury, cadmium, PCBs, dioxins, and PAHs) in the NY/NJ Harbor. In 2008 the Consortium reported that "dioxins were selected for study by the Consortium because of their impacts on fish and shellfish in the NY/NJ Harbor, their relatively high toxicity even at low concentrations, their ubiquity in sediments in the Harbor (e.g., the lower Passaic River and Newark Bay), and, thus, their potential impact on the economy of the region, especially the Port of NY & NJ."[15] The Consortium's recommendations include the following statement:[16]

> Cleanup of PCB-contaminated sites – particularly along the Passaic River – as well as the dioxin-contaminated Diamond Alkali Superfund site and its effects on the nearby Harbor, remains a (if not the) major priority. The Consortium has urged all litigating parties to focus their efforts on achieving early and effective action.

PCBs (polychlorinated biphenyls) are persistent organic compounds that were specifically designed to be non-flammable and chemically stable under very hot conditions so they could replace mineral oils that burn, be used for their lubricating and electrical insulating capacities, and in many other ways. PCBs were manufactured for many uses from 1929 until they were banned in 1979 because of their toxicity, but they continue to persist today, adhering to sediment particles in the water. PCBs persist in natural environments because microbes and other biota can't change them chemically. They are taken up by plants and eaten by animals on which they have harmful effects, and as they go up the food chain they accumulate in fatty tissues and become more and more toxic. They have probably been most harmful to some fish populations and to people who have eaten fish highly polluted with PCBs.

The "Risk Based Remedial Goal" for total PCBs in non-residential soils and river sediments has been 14 parts per billion (ng/g).[17] In the Lower Passaic River sediments, PCB levels were as high as 17,200 ng/g in the 1990s.[18] In many sediment samples taken from Newark Bay in 2005 and 2007 levels of PCBs exceeded 4,810 ng/g. (See Figure 5.[19])

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[15] New York Academy of Sciences Harbor Consortium. January 2008. "Safe Harbor: Bringing People and Sciences Together to Improve the New York/New Jersey Harbor. Page 46.

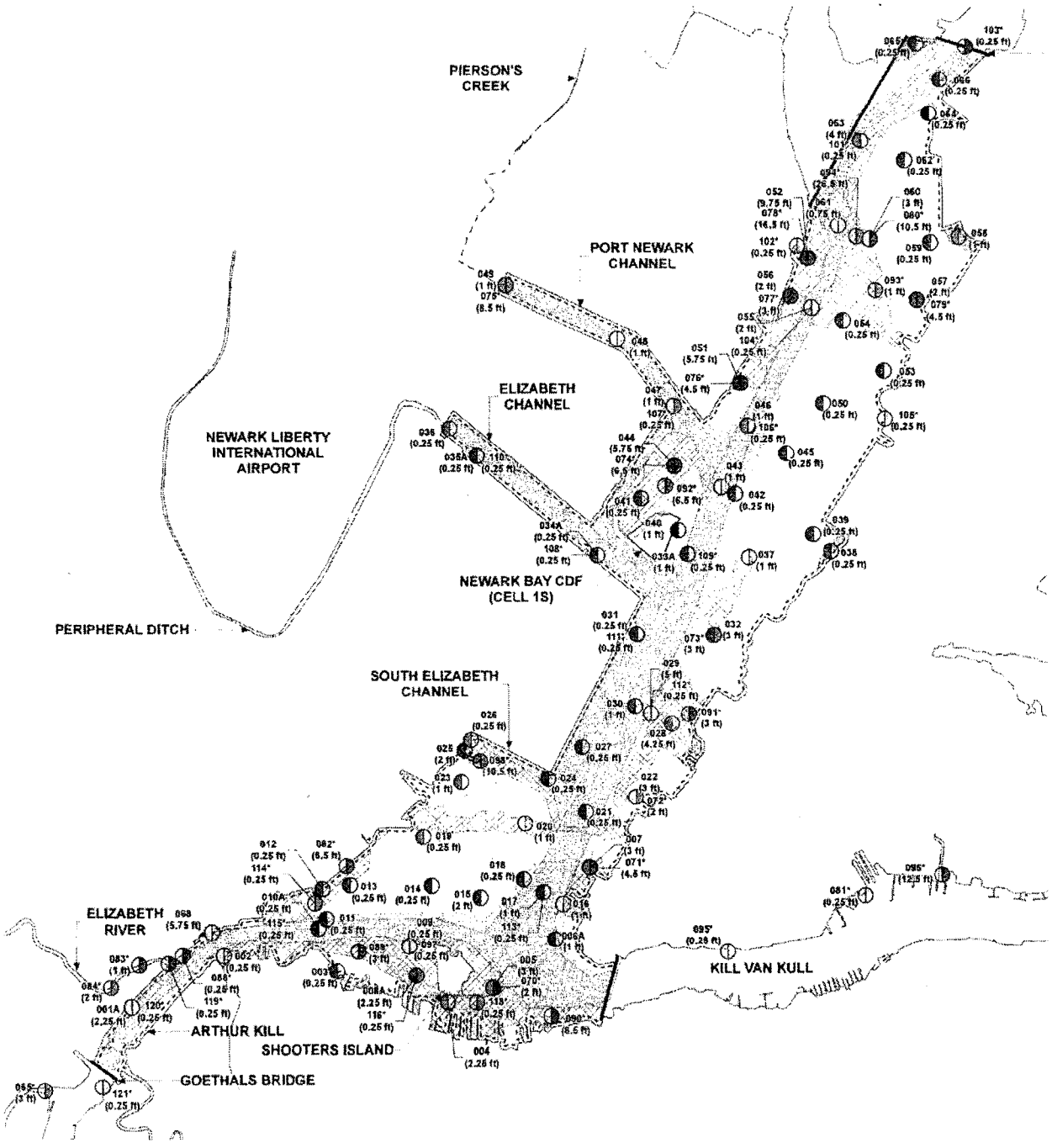
[16] *Ibid.* Page 47.

[17] Malcolm Pirnie, Inc. 2007. Lower Passaic River Restoration Project, Draft Source Control Early Action Focused Feasibility Study. Prepared for US Environmental Protection Agency, US Army Corps of Engineers, New Jersey Department of Transportation. June 2007. (FFS). Sections 2.4.1 & 2.4.2, pages 2-11 to 2-14, Tables 2-3 and 2-4.

[18] Lower Passaic River Restoration Project: Pathways Analysis Report. July 2005. Prepared by Battelle, under contract to Malcolm Pirnie, Inc., for US Environmental Protection Agency, Region 2 & US Army Corps of Engineers, Kansas City District. Table 1.

[19] Tierra Solutions, Inc. 2008. Phase I and Phase II Field and Data Report, Newark Bay Study Area Remedial Investigation. Phase I and Phase II Sediment Investigation Field and Data Report, Figure 4-12.

Figure 5 – PCBs in Newark Bay Sediments
Total Congener PCB Results - Core Maximum[20]
Sampled in 2005 and 2007
(Red = >4,810 ng/g)
(Green = 28.15-550 ng/g)
(Blue = <28.15 ng/g)



[20] Tierra Solutions, Inc. 2008. Phase I and Phase II Field and Data Report, Newark Bay Study Area Remedial Investigation. Phase I and Phase II Sediment Investigation Field and Data Report, Figure 4-12.

The dioxin, 2,3,7,8-TCDD (2,3,7,8-tetrachlorodibenzo-p-dioxin), was a contaminant in Agent Orange, which was manufactured at the Diamond Alkali plant at 80 Lister Avenue in Newark in the 1960s and used in Vietnam to defoliate plants. Dioxin is about the most toxic substance known to man. In 1984 the New Jersey Department of Environmental Protection (NJDEP) ordered a ban on the sale and consumption of fish and shellfish taken from the tidal Passaic River and striped bass and blue claw crabs taken from Newark Bay because the levels of dioxin found in fish tissue can cause cancer and other highly toxic effects.[21] This ban continues today, except that striped bass may be eaten occasionally.[22] The "Risk Based Remedial Goal" for this dioxin in river sediments has been 0.3 parts per trillion (pg/g).[23] Near the Diamond Alkali site in the Lower Passaic River sediments, dioxin levels were as high as 14,000 pg/g in the 1990s.[24] In 2005 and 2007 sediments that had become contaminated with dioxin produced in the 1960s at the Diamond Alkali site and were washed into Newark Bay still had levels over 666 pg/g.[25] (See Figure 6.)

Today, over a third of a century since PCBs and dioxin were last manufactured, the NJDEP is still advising people not to eat fish and shellfish from the Lower Passaic River, and has launched a public awareness campaign regarding its "**Blue Claw Crab Alert**" in the Newark Bay Region. The NJDEP "has found that **blue claw crabs** from the Newark Bay region are contaminated with harmful levels of dioxin and ... PCBs. Eating **blue claw crabs** from this region may cause cancer and harm brain development in unborn and young children. Fish consumption advisories in this region for **blue claw crabs** are **DO NOT CATCH! DO NOT EAT!** The Newark Bay Region is composed of Newark Bay, the Hackensack, Passaic, Elizabeth and Rahway Rivers and the Arthur Kill and Kill Van Kull."[26]

The removal of sediments highly contaminated with dioxin and PCBs from the waters of the Newark Bay region and throughout the NY/NJ Harbor will gradually help these waters to become "fishable" again, but only if the removal of dioxin and PCBs is sustainable. PCBs and dioxin persist today, as legacies of the past, because of their abilities to harm many types of biota, and to resist chemical changes even under incineration temperatures. To reduce this legacy of environmental harm, the carbon, hydrogen and chlorine atoms in these compounds should be split apart to form more benevolent compounds, such as carbon dioxide, water, and hydrogen chloride. The technology to do this is available today.

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[21] Belton, Thomas J., *et al.* 1985. A Study of Dioxin (2,3,7,8-Tetrachlorodibenzo-p-Dioxin) Contamination in Select Finfish, Crustaceans and Sediments of New Jersey Waterways. Office of Science and Research, New Jersey Department of Environmental Protection.

[22] New Jersey Department of Environmental Protection, Office of Science. 2011. Fish Advisories, Estuarine & Marine Waters. <www.state.nj.us/dep/dsr/fishadvisories/statewide.htm#newark.htm>

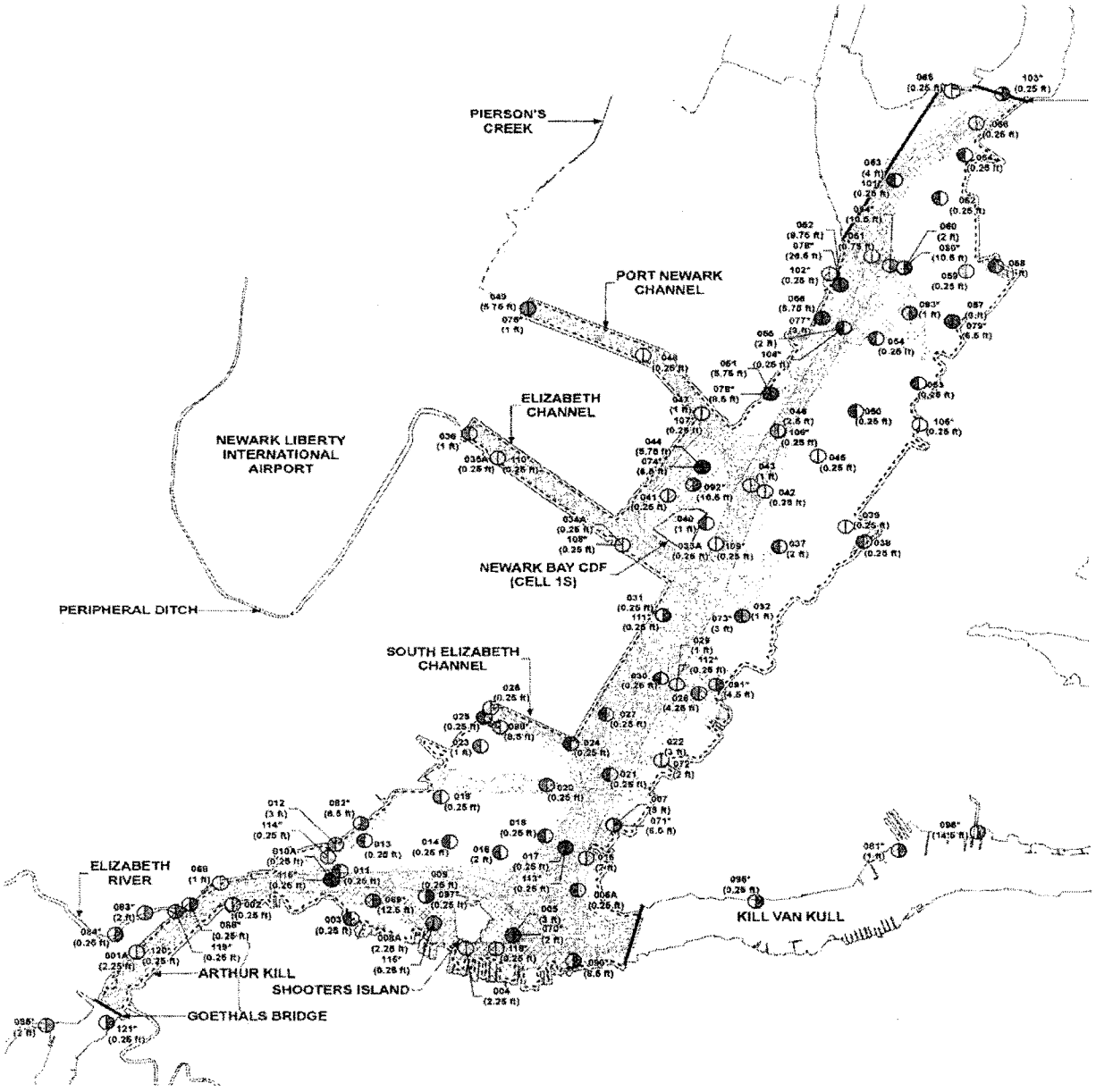
[23] Malcolm Pirnie, Inc. 2007. Lower Passaic River Restoration Project, Draft Source Control Early Action Focused Feasibility Study. Prepared for US Environmental Protection Agency, US Army Corps of Engineers, New Jersey Department of Transportation. June 2007. (FFS). Sections 2.4.1 & 2.4.2, pages 2-11 to 2-14, Tables 2-3 and 2-4.

[24] Lower Passaic River Restoration Project: Pathways Analysis Report. July 2005. Prepared by Battelle, under contract to Malcolm Pirnie, Inc., for US Environmental Protection Agency, Region 2 & US Army Corps of Engineers, Kansas City District. Table 1.

[25] Tierra Solutions, Inc. 2008. Phase I and Phase II Field and Data Report, Newark Bay Study Area Remedial Investigation. Phase I and Phase II Sediment Investigation Field and Data Report, Figure 4-13.

[26] New Jersey Department of Environmental Protection, Office of Science. 2011. Blue Claw Crab Alert, Newark Bay Region: DO NOT CATCH! DO NOT EAT! <www.state.nj.us/dep/dsr/crab-outreach/alert-english.htm>

Figure 6 – Dioxin in Newark Bay Sediments
2,3,7,8-TCDD Results - Core Maximum[27]
Sampled in 2005 and 2007
(Red = >666 pg/g)
(Green = 0.8.7-36.2 pg/g)
(Blue = <0.87 pg/g)



[27] Tierra Solutions, Inc. 2008. Phase I and Phase II Field and Data Report, Newark Bay Study Area Remedial Investigation. Phase I and Phase II Sediment Investigation Field and Data Report, Figure 4-13.

Dredged Material Management (DMM) Alternatives

In 1984 the "Diamond Alkali" site, which includes the property at 80 Lister Avenue in Newark as well as the contaminated Lower Passaic River, was declared a Superfund Site. The Diamond Alkali Superfund Site project became part of the Lower Passaic River Restoration Project (LPRRP) in 2000 and studies were extended into Newark Bay.[28] In the LPRRP Focused Feasibility Study (FFS), "sediments in the lower eight miles of the river were identified as a major source of contamination to the 17-mile" tidal portion of the river and to Newark Bay.[29] According to the Corps, one of the goals of the LPRRP is to provide a plan that will result in "a significant cost savings to the navigational dredging program related to dredged material management in the NY/NJ Harbor."[30] Thus, the "Phase 1 Removal Action" project, which will remove about 40,000 yd^3 (cubic yards) of the sediments most highly contaminated with dioxin from an area of the Lower Passaic River directly next to the land side of the Diamond Alkali site, and the "Lower 8 Miles" project are NY/NJ Harbor dredging projects. (Navigation channels that need to be dredged are shown in Figure 2.[31]) The dredged material management (DMM) plans for these projects will greatly influence DMM in Newark Bay, the harbor and far beyond. DMM alternatives that may be considered for the "Lower 8 Miles" project are evaluated here for use with sediments contaminated with PCBs and/or dioxin.

CAD (Confined Aquatic Disposal):

It has been proposed that 11 million cubic yards of the contaminated sediments to be dredged from the "Lower 8 Miles" stretch of the Passaic River be placed in deep holes dug into the clean clay in Newark Bay between the shipping channel and the City of Bayonne, as shown in Figure 7. The Corps describes CAD cells as "potential contingency options" for DMM of harbor dredgings.[32] If using CAD cells for these highly contaminated sediments is still considered a viable option, then we would like answers to the following questions. Given the likelihood of the release of dioxin and other contaminants from a CAD site by a boat straying from the navigational channel or other type of accident, who is responsible *in perpetuity* for preventing such accidents or cleaning them up if they happen? Who would pay the long term costs of monitoring and maintaining the CAD cells? Who owns the water in Newark Bay and the 200 acres of land beneath it? Who is responsible for keeping this land safe and healthy? Who would want all these contaminated sediments to be moved untreated from the Passaic River downstream into Newark Bay? Who would allow CADs to be built so close to berths 4, 6 and 8 at the Port Newark Marine Terminal and the navigational channels from which contaminated sediments need to be dredged soon, but for which there is no DMM facility? Who is responsible for the liabilities associated with a CAD? Has the whole harbor dredging dilemma has been caused because dumping in water has been considered "free", and a "large under-water footprint" is not a consideration for "CAD/CDF Disposal" for DMM?

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[28] U.S. Army Corps of Engineers, New York District; U.S. Environmental Protection Agency, Region II; New Jersey Department of Transportation, Office of Maritime Resources. April 2003. Project Management Plan, Lower Passaic River, New Jersey, Investigation and Feasibility Study for Remediation and Ecosystem Restoration.

[29] Malcolm Pirnie, Inc. 2007. Lower Passaic River Restoration Project, Draft Source Control Early Action Focused Feasibility Study. Prepared for US Environmental Protection Agency, US Army Corps of Engineers, New Jersey Department of Transportation. June 2007. (FFS). Executive Summary, page i.

[30] U.S. Army Corps of Engineers, New York District. 2011. Lower Passaic River Restoration Project, NJ. Lisa Baron, Chief, Harbor Programs Branch. Web-site: www.nan.usace.army.mil.

[31] Tierra Solutions, Inc. 2008. Phase I and Phase II Field and Data Report, Newark Bay Study Area Remedial Investigation. Phase I and Phase II Sediment Investigation Field and Data Report, Figure 4-13.

[32] U.S. Army Corps of Engineers, New York District. 2011. Dredged Material Management Plan for the Port of New York and New Jersey. Michael Millard, Project Manager. Web-site: www.nan.usace.army.mil.

Figure 7 – CAD Cells Proposed for Newark Bay

Off-site Treatment and Disposal:
In the "Phase 1 Removal Action" project "material excavated here will be taken off-site, treated and then disposed of in one of a handful of facilities permitted to accept such waste."[33] "Treatment" or sediment processing involves solids separation and dewatering.[34] The excavation and treatment processes are scheduled to be carried out in 2012.[35] Then the dewatered contaminated sediments are to be shipped by rail to facilities in Oklahoma and Utah. The economic costs of shipping wastes across the country are high, and so are the ecologic costs from greenhouse gas emissions. We do not know what the ecologic costs will be at these "Off-site" disposal facilities at this time because information about them has not been made available. However, past studies lead us to conclude that dumping such contaminated sediments anywhere in the U.S., Canada or elsewhere without appropriate pretreatment of the dredged material will cause high ecologic costs that lead to high economic costs. In any case this would not be a "Beneficial Use" of these sediments.

Biological Treatment by Wetlands Habitat Restoration:
The Corps' DMM Plan for the NY/NJ Port includes using dredged material for restoring wetlands.[36] This is a type of biological treatment. Some dredged materials from NY/NJ Harbor (50 ft Deepening) Navigation projects are to be used to help restore a marsh in Woodbridge, NJ.[37] However, sediments laced with PCBs and dioxin will not create a healthy habitat for wetland plants and animals because they were chemically created to resist the chemical changing forces of nature.

Biological Treatment of Waste Water:
Sewage treatment plants and septic systems remove organic pollutants from water by using microorganisms that consume the contaminants and convert them into non-hazardous substances. However, dioxin and PCBs are indigestible and may be toxic to microorganisms as well as to people, and they will persist in sediments treated by biological methods.

Sediment Washing:
Sediments dredged from the Lower Passaic River near the Diamond Alkali site in 2005 were used in the BioGenesis^{SM} sediment washing demonstration project to "produce high-end topsoil", a beneficial use product.[38] "The BioGenesis^{SM} Sediment Decontamination Technology is a physical/chemical process that uses impact forces (cavitation/collision) and chemical forces (oxidation with hydrogen peroxide) to strip contaminants from the surface of sediment particles and

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[33] U.S. Environmental Protection Agency. 2008. EPA Signs Agreement with Companies to Remove Major Source of Passaic River Contamination, The Lower Passaic River Restoration Project, Part of the Diamond Alkali Superfund Site, June 2008.

[34] Tierra Solutions, Inc. 2008. Phase I Engineering Evaluation/Cost Analysis, CERCLA Non-Time Critical Removal Action – Lower Passaic River Study Area, November 2008, Revision 3. Pages 7-3 to 7-6.

[35] Web-site: passaicremovalaction.com

[36] U.S. Army Corps of Engineers, New York District. Dredged Material Management Plan for the Port of New York & New Jersey Harbor. 2011. Michael Millard, Project Manager. Web-site: www.nan,usace.army.mil

[37] U.S. Army Corps of Engineers, New York District. New York & New Jersey Harbor (50 ft Deepening) Navigation Project. 2011. Bryce Wisemiller, Project Manager. Web-site: www.nan,usace.army.mil

[38] Malcolm Pirnie, Inc. 2007. Lower Passaic River Restoration Project, Draft Source Control Early Action Focused Feasibility Study (FFS). Prepared for US Environmental Protection Agency, US Army Corps of Engineers, New Jersey Department of Transportation, June 2007, pages 3-15 & 3-16. & Appendix H, BioGenesis Sediment Washing Demonstration Project, pages H-15 to H-86.

suspend them in the water phase where they can be separated from the sediment."[39] The sediments are then mixed with clean organic matter to make manufactured soil. The wash water is piped to the nearest sewage treatment plant. For some sediments dredged from the NY/NJ Harbor this treatment may be appropriate, but not for those contaminated with PCBs or dioxin. The "chemical forces" used do not change these compounds. Most of the PCB contaminants would be carried attached to very small particles of dirt in the wash water to the sewage treatment plant where they would contaminate the sludge or the treated water. The dioxin would be divided between the treated sediment and the waste water, and able to do harm in either milieu.

Thermal Oxidation (Incineration):

Incineration is effective at reducing the mass of solid waste because much of the organic matter burns up and goes into the air as carbon dioxide, water and other compounds. Incinerator feedstock must be able to burn under its own calorific value, but the dredged materials from the NY/NJ Harbor will not burn because they are mostly mineral matter which has no calorific value. Incinerators can produce dioxins, and do produce ash which may contain leachable heavy metals. Disposal of the ash poses both ecologic and economic problems. Consequently, thermal destruction by oxidation at temperatures in the range of 1,400°F to 1,800°F should not even be considered as an option for the decontamination of sediments dredged from the Lower Passaic River and Newark Bay.

"Thermal Destruction" and Vitrification:

In the 2007 FFS for the LPRRP various *ex situ* treatment processes to decontaminate the dredged materials were assessed. One of these processes was "thermal destruction" which "uses high temperatures (typically between 1,400°F and 2,200°F) to volatize and combust organic chemicals."[40] Incineration is such a process but was not considered in the FFS. What was evaluated in the FFS as a "thermal destruction" process was the thermal-chemical (Cement-Lock®) process, which operates at higher temperatures in the range of 2,400°F to 2,600°F.[41] The FFS describes vitrification as "a process in which higher temperatures (2,500°F to 3,000°F) are used to destroy organic chemicals by melting the contaminated dredged material to form a glass aggregate product".[42] The vitrification technology was to be considered for further evaluation for the LPRRP. The FFS states that "the thermal treatment process options, thermal destruction and vitrification, meet the criteria of permanently treating the sediments while achieving the highest treatment efficiencies."[43] The vitrification process developed by the Minergy Corporation is being used to treat sewage treatment plant wastewater sludge, and pulp and paper plant wastewater solids. It was considered for treatment of the PCB contaminated sediments dredged from the Lower Fox River in Wisconsin, but these dredged materials are going to a landfill instead because this DMM is cheaper. The thermal "destruction" (Cement-Lock®) process was selected for further study in the LPRRP because "it produces a beneficial use product that offsets a significant portion

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[39] BioGenesis Washing BGW, LLC. 2009. Demonstration Testing and Full-scale Operation of the BioGenesis℠ Sediment Decontamination Process, Keasbey, New Jersey. Page ES-11.

[40] Malcolm Pirnie, Inc. 2007. Lower Passaic River Restoration Project, Draft Source Control Early Action Focused Feasibility Study (FFS). Prepared for US Environmental Protection Agency, US Army Corps of Engineers, New Jersey Department of Transportation, June 2007, page 3-17.

[41] *Ibid.*

[42] *Ibid.*

[43] FFS. Page 4-8.

of the treatment costs, and because it has been shown to achieve a high treatment efficiency for Passaic River sediments based on the results of a pilot demonstration project in which 16.5 tons of Passaic River sediment were treated."[44] The "draft" FFS also states that the thermal-chemical (Cement-Lock®) process "is one of the only technologies proven as effective in treating ... (dioxins, PCBs and PAHs) detected in the sediment" of the lower 8 miles of the Passaic River.[45]

Thermal-Chemical (Cement-Lock®) Treatment

Development of Thermal-Chemical Technology:

The thermal-chemical (Cement-Lock®) technology uses a rotary kiln that is fueled by natural gas to melt multi-contaminated sediments. The process is similar to what happens in an active volcano. In a rotary kiln operating at ~2,500°F the organic contaminants are disassociated or destroyed, and the non-volatile heavy metals are encapsulated into the siliceous matrix that forms from the sediments to produce Ecomelt®, which can be used as a 30-40% replacement for Portland cement in concrete, a beneficial use product. Rotary kilns have been used to produce Portland cement for more than a hundred years. For over 65 years the Gas Technology Institute (GTI) has been a world leader in the research and development of energy technologies using gas. This technology for remediating contaminated sediments was conceived at GTI in 1994, and developed from bench-scale to pilot-scale in 1994 to 2005. EPA, Region 2, and the US Department of Energy, Brookhaven National Laboratory, have worked with GTI on this project since 1995. In 2000 the NJ Department of Transportation, Office of Maritime Resources, selected this technology "to be evaluated for its applicability to the treatment of sediment dredged from navigational channels."[46]

Pilot-Scale and Demonstration-Scale Testing of Thermal-Chemical Technology:

ENDESCO Clean Harbors, LLC, a subsidiary of GTI, built a demonstration plant in Bayonne, NJ. Sediments dredged from the Stratus Petroleum site in Newark Bay and then dewatered were used in a pilot test of the Cement-Lock® technology at this plant in 2005.[47] This test led to equipment modifications that needed to be retested.[48] The retesting occurred in November 2006, but was halted early for several reasons. In December 2006 and in May 2007 demonstration-scale tests of longer duration were conducted using more contaminated sediments dredged from the Passaic River near the Diamond Alkali site. The results from these tests show that the Cement-Lock® technology "can achieve high destruction and removal efficiencies for contaminants of concern, specifically dioxins and furans and PCBs" (treatment efficiency of >99.9%).[49] Some of the Ecomelt® produced was mixed with Portland cement to make high quality concrete paving at Montclair State University. GTI and its subsidiary, Endesco, learned much from the pilot and demonstration test projects. When we considered the technical problems that occurred during these tests, we concluded that they could be corrected if appropriately addressed as discussed below.

Technologies Involved in the Thermo-Chemical Treatment of Dredged Materials:

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[44] *Ibid.*

[45] FFS. Page 3-17.

[46] Endesco Clean Harbors, LLC, prepared by Michael C. Mensinger, Gas Technology Institute. July 2008. Sediment Decontamination Demonstration Program – Cement-Lock® Technology, Final Report: Phase II Demonstration Tests with Stratus Petroleum and Passaic River Sediments. Submitted to: NJ Department of Transportation, Office of Maritime Resources; US Department of Energy, Brookhaven Science Associates, LLC. Page iii.

[47] *Ibid.*

[48] *Op. cit. #20.* Page iv.

[49] *Op. cit. #20.* Pages 103, vii.

Since 2008 GTI and its partners in Volcano Partners, LLC, have brought together several different business entities with their own expertise that would like to cooperate in the development and operation of facilities for the manufacture of a cement extender (Ecomelt®) from contaminated sediments dredged from the NY/NJ Harbor and elsewhere. Information from some of these partners is included in this report. Tetra Tech, a leader in the hazardous waste remediation industry, recently released a "Summary of Project and Design Updates for Cement-Lock® Technology Manufacturing Plant".[50] As with most manufacturing businesses, there are at least four different processes that would be involved in the thermo-chemical treatment of dredged materials. Each of these processes involves different technologies. Each process requires different types of operational expertise. The technological modifications and expertise that Volcano Partners suggest be used in each of these four processes are evaluated here.

Front End Materials Handling Process -- Debris Removal, De-watering of Dredged Materials:
In the test runs the dewatered sediments fed into the rotary kiln should have been drier. This problem and other problems encountered with feed handling are correctable. Tetra Tech is helping to design the systems to offload the dredged sediments from barges, to remove debris, and dewater the sediments to 50% solids content, to deliver the dewatered sediments to the treatment factory, and to blend Cement-Lock® technology additives with the sediment to reduce the moisture content to 40% or below.

Manufacturing Process -- Design/Build/Operate Thermo-Chemical Treatment Factory:
The demonstration tests proved that a cement extender (Ecomelt®) can be manufactured from contaminated sediments. In our judgment the improvements in the design of the system being proposed to correct problems encountered in the demonstration tests make sense. Tetra Tech, Foster Wheeler Corporation (FWC), design engineers in rotary kiln technology, and ABB, an industrial leader in cement plant planning, are helping in planning the design, construction and operation of a Cement-Lock® facility using a rotary kiln thermal-chemical processing technology. In this system dewatered sediments that have been mixed with feed additives (slag modifiers) are fed through a kiln on a double screw feeder conveyor. The heat for processing the sediments comes from burning natural gas with air. The amount of air and oxygen (O_2) used is controlled by a combustion air fan so that the gas, which is mostly methane (CH_4), is used efficiently to form carbon dioxide (CO_2) and water (H_2O), and so that nitrogen oxide (NO_x) formation is minimal. Air contains about 78% nitrogen (N_2) and 21% oxygen (O_2). As the dredged sediments are rolled through a kiln and heated to high temperatures of ~2,500°F most of the sedimentary material is melted into a molten slag, and the organic matter is converted to gases, especially CO_2 and water. The temperatures used are even hot enough to convert PCBs and dioxin to CO_2, water, hydrogen chloride (HCl), and chlorine gas (Cl_2). The molten slag drops from the kiln and the walls of the secondary combustion chamber into a pool of water where it is quenched and cooled. The slag is then conveyed from the pool to a grinder/pulverizer/blender to become Ecomelt®. The rotary kiln thermal-chemical treatment technology being proposed by FWC has already been used to treat a variety of heterogeneous waste streams, including contaminated soils, sediments, and sludges. In fact, FWC's rotary kiln projects include the Clean Harbors Aragonite facility in Grantsville, Utah, which has been in operation since 1991, and which has an EPA permit for PCB Disposal.[51] The Destruction and Removal Efficiency (DRE) for PCBs at this plant have at times exceeded 99.999999%. However, this facility produces an ash, which when deposited in a landfill can produce leachable heavy metals such as lead and mercury. The Cement-Lock® facility proposed

[50] Tetra Tech EC, Inc., prepared by Steve McGee. November 30, 2011. Summary of Project and Design Updates for Cement-Lock Technology Manufacturing Plant.

[51] U.S. Environmental Protection Agency. 2011. Web-site: www.epa.gov/hazard/tsd/pcbs/pubs/stordisp.htm.

for this area will be the first in the U.S. and Canada to be designed for the treatment of sediments contaminated with both legacy pollutants and heavy metals.

Waste Management Process -- Air Pollution Control and Monitoring:
This thermo-chemical treatment process uses lots of energy by burning natural gas with air to heat the rotary kiln system (Ecomelt® generator). Energy wastage would be minimized by using the superheated flue gases to produce steam to generate electricity. The Volcano Partners, including ADA/NORIT Americas JV, are now proposing to build and operate a Cement-Lock® plant with "state-of-the-art" air pollution controls. This process forms acidic gases, NO_x (nitrogen oxides), SO_x (sulfur oxides), and HCl (hydrogen chloride), which can cause acid rain if released to the air. Before being emitted the flue gases would be cooled with direct water injection. NO_x emissions would be reduced by selective non-catalytic reduction, which would convert the NO_x to the nitrogen and oxygen gases that fill the air. Injection of lime into the flue gases would convert SO_x and HCl gases to solid particles, which would then be captured in fabric filter bag houses. Mercury (Hg) becomes a gas in this treatment process and must be captured. Absorbing gaseous mercury on impregnated powdered activated solid carbon particles which are caught in filter bags is proposed for mercury removal. Powdered activated carbon would also be used to remove any dioxins or furans that may be formed in the system. The proposed Cement-Lock® treatment process would not produce any waste water. The solid fine particulates caught in bag houses can be effectively managed and might even be useful. The cleaned flue gases will be lifted through a gas stack tall enough to allow for proper dispersion into the atmosphere. It is our judgment that the air pollution control systems proposed by the Volcano Partners are designed to be operated so as to exceed mandated air emissions standards.

Disposition of Manufactured Product -- Beneficial Use of Cement Extender (Ecomelt®):
It has been demonstrated that contaminated sediments, even those from the Lower Passaic River, can be melted to make Ecomelt®, mixed with Portland cement, and then used to make high grade concrete. There are many benefits to be gained from using contaminated sediments to make Ecomelt®. The organic contaminants, including PCBs and dioxins, that adhere to the sediments are destroyed in the Cement-Lock® rotary kiln process. Also this process immobilizes some of the non-volatile heavy metals in the glassy matrix of Ecomelt®. Although some parts of the processes needed in the manufacture of Ecomelt® are more expensive than those in the manufacture of Portland cement, the values to be gained in cleaning up the contamination should offset these costs. U.S. Concrete may help in selling the Ecomelt® product. In any case the production of this product would certainly be a beneficial use of contaminated sediments.

Site for Thermo-Chemical Treatment Facility:
Finding an appropriate site for the development of a thermal-chemical treatment facility for DMM of contaminated sediments is critical for implementing these dredging projects and many more needed along the eastern coast of the country. The site must be easily accessible by ship, and there should also be good rail and highway facilities nearby. The site must be large enough to accommodate all the necessary facilities. It would be necessary to obtain all the permits needed to develop and operate a thermo-chemical treatment facility for DMM and other contaminated sediments at the site. Sites in densely populated areas where many people are already suffering from air pollution should probably be avoided. There are sites along the Arthur Kill or Raritan River that meet these criteria. The use of such a site for the decontamination of materials dredged from the Lower Passaic River and Newark Bay should be considered "Local Decon" instead of "Off-site" because without such a facility within the NY/NJ Harbor area these contaminated dredged materials would have to be shipped out west. Considering such a site as an area of land within the Diamond Alkali Superfund Site might help facilitate the "Lower 8 Miles" dredging

project. (The Arthur Kill is within the Diamond Alkali Superfund Site, as shown in Figure 1.) The site should also become an "active upland dredged material placement site" that is permitted by the Corps to receive contaminated sediment in addition to clean materials dredged from the harbor. If a local site were to be approved soon, then the dewatered dredged sediments from the "Phase 1 Removal Action" project might be stored on this site instead of being shipped far away. This would be less costly both economically and ecologically.

Evaluation of Thermo-Chemical Treatment for DMM:

As in the development of most new technologies, there were problems encountered in the demonstration-scale testing of the Cement-Lock® technology in Bayonne in 2006 and 2007. Since then the Volcano Partners have proposed ways to design and operate facilities for each of the four processes involved in cleaning contaminated dredged materials to produce a product for beneficial use (Ecomelt®). In our judgment these problems are being well addressed in the current phase of planning for a treatment facility. After considering the options available for the management of materials that should be dredged from the Lower Passaic River, Newark Bay, NY/NJ Harbor and elsewhere we find that the thermo-chemical treatment option being proposed by the Volcano Partners is both ecologically and economically sensible and sustainable.

Sustainable Actions for Dredging and DMM in the NY/NJ Harbor Region

For over forty years we have been advocating for the restoration of the Lower Passaic River to navigable and fishable conditions, but not much has been done except for studying the pollution. The pollution has spread into Newark Bay and beyond. Now shipping in the NY/NJ Harbor is endangered by contaminated sediments clogging navigation channels and berths. In 2008 the Port's three major container terminals handled goods worth over $190 billion.[52] Unless the Port's "infrastructure" is repaired soon, there could be serious economic repercussions. This repair requires extensive dredging of contaminated sediments in the very near future. Where to dredge first and how to manage these dredged materials are issues that need to be resolved now! We recommend that the following dredging and dredged material management (DMM) actions be taken as soon as possible.

Action 1, Remove Legacy Pollutants

The presence of elevated levels of the legacy pollutants, dioxin and PCBs, in harbor sediments is causing the biggest problems for the health of the fish and other biota living in these waters, and the health of the people eating fish from these waters. In order to make these waters "fishable" again as rapidly as possible, the sediments loaded with high concentrations of dioxin and PCBs should be dredged as soon as possible. This is what the "Phase 1 Removal Action" and "Lower 8 Miles" projects are attempting to do. This action will also help slow the migration of sediments contaminated with legacy pollutants into other waters, especially into Newark Bay. We suggest that dredging in the "Lower 8 Miles" project occur before major dredging occurs in Newark Bay, perhaps starting in 2013, so that some of the resuspended sediments contaminated with these legacy pollutants are removed later.

The legacy pollutants, dioxin and PCBs, that need to be dredged are on land beneath water which in the past has been considered "free", having no economic value, and therefore available for abuse. Who is responsible for protecting these lands and waters from abuse? For over seventy years since the 1940s the Federal Government has neglected its duty to keep the authorized

[52] U.S. Army Corps of Engineers, New York District. 2011. New York & New Jersey Harbor (50 ft Deepening) Navigation Project. Bryce Wisemiller, Project Manager. Web-site: www.nan.usace.army.mil.

navigation channels in the Lower Passaic River clear of contaminated sediments. "The Federal interest in navigation derives from the Commerce Clause of the Constitution."[53] The Corps is the Federal agency responsible for maintaining the navigational channels of the New York-New Jersey Harbor, including the channels in the Lower Passaic River.[54] Therefore, in our judgment, the Corps should fulfill its responsibilities to dredge and restore the navigational channels of the lower eight miles of the Lower Passaic River, and the Federal government should fully fund this aspect of the "Lower 8 Miles" project. Under authorization from the Water Resources Development Act, the Corps lists the mission priorities of their civil works program as follows:[55]

- Navigation (Deep draft)
- Ecosystem Restoration
- Flood Damage Reduction (Coastal and Riverine)

A "Lower 8 Miles" project that removes most of the sediments highly contaminated with PCBs and dioxin and restores navigational capacity to the lower eight miles of the Lower Passaic River would meet all these mission priorities. In the Water Resources Development Act of 1999 the Passaic River is listed as one of eight priority sites. Funding up to $50 million per year may be used to "remove and remediate contaminated sediments from the navigable waters of the United States for the purpose of environmental enhancement and water quality improvement if such removal and remediation is requested by a non-Federal sponsor and the sponsor agrees to pay 35 percent of the cost of such removal and remediation."[56] This should be a source of funding that can be used to remove contaminated sediments that are outside of the navigational channel. The State of New Jersey should be the non-Federal sponsor, and should request that the Corps bear 65% of the costs of removing the contaminated sediments from outside of the navigational channel.

Action 2, Move Dredged Sediments from Water to Land

Most of the sediments that need to be dredged from the water in order to make space for ships to navigate were originally washed off the land. This means that the river and bay have less space for water than before, and the water rises higher during storms and tidal surges which causes more flooding. Therefore, it is beneficial to move the dredged sediments back onto land rather than leaving them in water at the HARS or in a CDF or CAD. Since 1969 the Passaic River Coalition has been seeking solutions for reducing flooding in the Passaic River Basin, one of the most flood prone river systems in the United States. Having contaminated sediments dredged out of the Lower Passaic River and Newark Bay and used beneficially on land would reduce the risks from flooding in the future. This is especially true in these times of rising sea levels due to global climate change. Therefore, implementation of these dredging projects with DMM on land should reduce potential losses caused by flooding. Among the many beneficiaries of reducing flooding in the future should be the Federal Government, which is responsible for providing aid to flood victims under the Federal Emergency Management Act (FEMA).

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[53] U.S. Army Corps of Engineers. 2000. ER1105-2-100, 22 April 2000. Appendix E, Civil Works Missions and Evaluation Procedures, Section II-Navigation, page E-18.

[54] FFS, Executive Summary, pages ii-iii.

[55] U.S. Army Corps of Engineers. 2007. Passaic River Basin, New Jersey, Congressional Staff and Stakeholders Briefing, April 5, 2007.

[56] Water Resources Development Act of 1999, Section 224.

Action 3, Decontaminate Dredged Sediments for Beneficial Uses

In 1995 we wrote that the U.S. Army Corps of Engineers (Corps) "is in a unique position ... to provide the people of New Jersey and New York, as well as the rest of the country, with a plan for reaching a permanent solution to the problems associated with dredging the harbor."[57] In 2008 we were again "advocating that a processing facility, which would store dredged sediments temporarily on land, and then treat them so that they could be used beneficially, be developed ... Such a facility has long been needed so that harbors along the East Coast can be dredged and revitalized, and so that Brownfields can be reused to the economic benefit of the region."[58] Now in 2011 there is the Volcano Partners' proposal to build and operate such a facility. This facility can presumably be built and operated with private funding. For the "Lower 8 Miles" project the cooperating parties, who are Potentially Responsible Parties (PRPs) in this Superfund case, might pay the tipping fees for the dredged materials. We recommend that the DMM plan proposed by the Volcano Partners be included in the first draft of the "Lower 8 Miles" Proposed Plan, reviewed, revised as necessary, and implemented as soon as possible. There will be many benefits from using local sediments to make cement and concrete instead of importing them from far away.

The Challenge: Dredged Material Management (DMM)

Now is the time for the Corps and EPA to act to have the "Lower 8 Miles" dredged. The toxic effects of dioxin and PCBs on people and other biota can be quite harmful. Most of the dioxin and PCB molecules found on sediments here and elsewhere in the world were produced more than a third of a century ago, before 1979, and they remain unchanged today. The concentrations of dioxin and PCBs on sediments in the "Lower 8 Miles" of the Passaic River may be the highest in the world.

The Diamond Alkali Superfund Site has been on the Superfund National Priorities List since 1984. The critical unresolved issue throughout these decades of efforts has been how to manage sediments highly contaminated with PCBs and dioxin that should be removed by dredging from the Lower Passaic River and elsewhere in NY/NJ Harbor waters. Procrastinating decades longer will not substantively reduce the total mass of sediments contaminated with these legacy pollutants in these waters. The molecular structure of these pollutants will not be changed by biological forces. Although the contaminated sediments will be moved around in these waters and buried under other sediments, their potential for causing harm to fish and other biota will not be substantially reduced over time. Removing significant volumes of these sediments that are heavily coated with PCBs and dioxin from the "Lower 8 Miles" by dredging, and then subjecting these sediments to the DMM thermo-chemical treatment proposed by the Volcano Partners should completely destroy these legacy pollutants, removing them from the local and global environment forever.

Now is the time to meet the Corps' challenge to develop a Dredged Material Management (DMM) Plan that gives "special emphasis to beneficial uses of the material needing to be dredged to

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[57] Filippone, Ella F. & Anne L. Kruger, Passaic River Coalition. 1995. Letter to Mr. Joseph J. Seebode, Chief, Regulatory Branch, U.S. Army Corps of Engineers. Re: Public Notice Number 95-04370-J1, Scoping for the Preparation of an Environmental Impact Statement for the Construction and Operation of a Confined Disposal Facility in Newark Bay, New Jersey.

[58] Filippone, Ella F. & Anne L. Kruger, Passaic River Coalition. 2008. Letter to Mr. Richard L. Tomer, Chief, Regulatory Branch, U.S. Army Corps of Engineers. Re: Application by Port Authority of New York & New Jersey, Newark Bay Confined Disposal Facility (NBCDF), Proposed Extension of the Date to Close and Cap the NBCDF, Public Notice Number: NAN-2007-1531-WSC.

maintain efficient waterborne transportation into and out of the Port."[59] We recommend that the DMM Plan proposed by the Volcano Partners be tried in the "Lower 8 Miles" project.

The development of an effective DMM facility for sediments dredged from the "Lower 8 Miles" of the Passaic River would be an "infrastructure repair" project that is critical for the future economic well-being of the country. By dredging contaminated sediments from the Lower Passaic River, Newark Bay and the NY/NJ Harbor, and treating them on land so they can be used beneficially, both the ecologic and economic vitality of the region can be reinvigorated. As the Corps has noted, "The Port of New York and New Jersey is the largest port on the East Coast, providing more than 230,000 direct and indirect jobs in port related activities."[60] It has been estimated that achieving the goal of clean sediments throughout the harbor can save at least $25,000,000 per year in costs of maintaining the harbor's water transportation infrastructure.[61] Removing the sediments highly contaminated with legacy pollutants and helping to restore healthy habitats for fish will improve other economic "opportunities for recreation, tourism, and fisheries – industries valued at over $20 billion per year that depend on a clean Harbor Estuary."[62]

We (Ella Filippone, Executive Administrator of the Passaic River Coalition (PRC), and Anne Kruger, Ph.D., Senior Scientist for the PRC since 1992) have been actively monitoring the technical aspects of this case since its inception in 1984, and have been involved in public participation through community involvement groups, such as the Community Advisory Group (CAG). We hope that the DMM issues will be resolved soon. Perhaps consideration of the following questions will be helpful.

- Are we willing to move these dredged sediments covered with legacy pollutants, PCBs and dioxin, from one place to another within the NY/NJ Harbor area or within the USA without DMM actions?
- Can we envision a process that will permanently remove most of the harmful impacts of PCBs and dioxin from the NY/NJ Harbor area?
- Can we as a society destroy pollutants that are considered indestructible?
- What kind of legacy do we want to leave for future generations?

We hope that the actions we're recommending will stimulate discussion among involved parties so that mutually acceptable ways will be found to fund these projects as soon as possible. We hope that you and your community will work with us to encourage the implementation of these projects so that in the future the millions of people living and working in the area, as well as visitors from around the world, can enjoy the ecologic and economic benefits of a healthy river and harbor. This effort is critical for restoring ecologic health and economic prosperity to this region!

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[59] U.S. Army Corps of Engineers, New York District. 2011. Dredged Material Management Plan for the Port of New York and New Jersey. Michael Millard, Project Manager. Web-site: www.nan.usace.army.mil.

[60] U.S. Army Corps of Engineers, New York District. 2011. New York & New Jersey Harbor (50 ft Deepening) Navigation Project. Bryce Wisemiller, Project Manager. Web-site: www.nan.usace.army.mil.

[61] New York/New Jersey Harbor Estuary Program. 2008. Regional Sediment Management Plan, October 2008, page iv.

[62] *Ibid.* Page iv.